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THE DEMAND FOR CIGARETTES IN TAIWAN: DOMESTIC VERSUS IMPORTED CIGARETTES

CHEE-RUEY HSIEH*
TEH-WEI HU**
CHIEN-FU JEFF LIN***

ABSTRACT

This paper uses annual time series data from Taiwan to empirically estimate the demand for cigarettes, in consideration of the import liberation of foreign cigarettes and of anti-smoking campaigns. The results indicate that the price elasticities for domestic and imported cigarettes are -0.6 and -1.1, respectively. The cross-price elasticities are 0.08 for domestic and 2.78 for imported cigarettes. The spread of cigarette health information has had a significantly negative effect on cigarette consumption. In addition, our analysis offers mild support to the argument that opening the markets to imported cigarettes has resulted in significant increases in overall cigarette consumption.

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* The Associate Research Fellow, the Institute of Economics, Academia Sinica, Taipei, Taiwan
**Professor of Health Economics, University of California, Berkeley, CA
***Associate Professor of Economics, National Taiwan University, Taipei, Taiwan

I. INTRODUCTION

The existence of health hazards resulting from cigarette smoking has been widely recognized since the 1960s. This recognition has caused cigarette consumption in most developed countries to fall steadily over the past thirty years.[1] The declining demand for cigarettes in developed countries has forced multinational cigarette manufacturers to turn to other markets. U.S. trade policy has played an important role in these marketing efforts. In the name of free trade and under the threat of retaliatory trade sanctions (Section 301 of the 1974 Trade Act), Japan, Taiwan, South Korea, and Thailand all have opened their doors to American cigarettes during the past decade (Chaloupka and Laixuthai, 1996). Given the substantial health consequences of smoking, this open-door policy has created several concerns.

The first concern is whether cigarettes imports increase overall cigarette consumption. Based on annual data of 10 Asian countries, Chaloupka and Laixuthai (1996) found that per capita cigarette consumption increased an average of 10 percent in 1991 among the four Asian countries that opened their doors to imports. However, few if any empirical studies have investigated the impact of cigarette imports in individual countries.

Given the evidence that imports have resulted in significant increases in cigarette smoking on average, another question is whether government policies to discourage smoking are effective. Around the world, governments have used a number of alternatives to try to control cigarette smoking (Warner, 1990). Developed countries, for instance, have long used cigarette taxation as a tool to reduce consumption. The effectiveness of taxation, which depends on the price elasticity of cigarette demand, has been widely recognized in empirical literature (Viscusi, 1992). Sung et al. (1994) found that the price elasticity of cigarette demand was -0.40 in the short run and -0.48 in the long run. This indicates that a tax increase, such as that imposed in California in January 1989 (an additional 25 cents per pack), can greatly reduce cigarette consumption. In fact, the California tax reduced consumption by 11.2 percent in the

short run and 13.4 percent in the long run (Sung et al., 1994). However, literature on price elasticities for cigarette demand are largely based on data from developed countries. Whether taxation would be as effective in newly industrialized or less developed countries remains unclear.

In addition to increasing cigarette excise taxes, governments regulate the sale of cigarettes, particularly by requiring warning labels on cigarette packs and in advertising. Additionally, they provide information directly on the adverse effects of smoking. Following these approaches, Taiwan began requiring warning labels on cigarette packaging and in advertising after it opened the market for cigarette imports in 1987. [2] And, in response to the marketing campaigns of foreign tobacco manufacturers, the Taiwanese government along with many private organizations, has sponsored anti-smoking media campaigns. However, it has not been well understood until now whether these anti-smoking policies have significant impact on overall cigarette consumption in Taiwan.

The purpose of this paper is to provide empirical evidence for the demand for cigarettes. It considers both the impact of cigarette imports and of anti-smoking campaigns. We analyze time-series cigarette sales data for Taiwan for the years 1966 through 1995. For the time series analysis, the recent development of unit root and cointegration studies suggested a standard procedure to explore the structure of a single time series and relationships among variables. The unit root tests, e.g., Dickey-Fuller (DF) test in Dickey and Fuller (1979) , augmented Dickey- Fuller (ADF) test in Said and Dickey (1984), Z test in Phillips (1987), Phillips and Perron (1988), help us to distinguish between the stochastic trend and deterministic trend which address the shocks are whether with permanent or temporary effect. In a similar vein, Phillips (1986) provided the distribution of estimators in the regression contains unrelated unit root process. This solves the puzzle of spurious regression raised in Granger and Newbold (1974). The cointegration analysis proposed by Granger (1986) and Engle and Granger (1987) provides a way to test the long run equilibrium hypothesis by checking the residuals from a linear combination of economic variables

which are all with unit root. The coefficients in the cointegration regression are super-consistent because the estimators converge in a faster rate than the usual stationary variables. The procedure developed in Engle and Granger (1987) is a two step method and with only one cointegrating vector is considered. Johansen (1988) and his subsequent works examine system of equations from the view of cointegration space spanned by different cointegrating vectors. Furthermore, the modeling of system of equations is processing by the methodology of error correction model which involves adjustments of short run dynamics and long run disequilibrium. However, those analysis do not discuss the simultaneity in the system. Recently Hsiao (1997) demonstrated the fundamental issues on structural equation modeling raised by the Cowels Commission remain valid. The super-consistency result from the regression among unit root process does not render the issue of simultaneous bias irrelevant. He showed that only one set of conditions is needed that simultaneously identifies both short run dynamics and long run relations. He also concluded that whatever the speed of convergence of the structural equation estimators, the Wald type test statistics are still asymptotically chi-square distributed under the null. These discussions revoke the contribution of econometrician in seventy and bridge the old and recent works in econometrics.

The focal points of this paper are: (1) to estimate the price elasticity of cigarette demand in Taiwan; (2) to estimate the impact of opening cigarette market; (3) to evaluate the impact of anti-smoking policies on cigarette consumption; and, (4) to investigate whether imported and domestic cigarettes are substitutes. The next section contains the empirical framework for our analysis. Section III describes the data and the variables. Section IV analyzes the empirical results. Further discussion and conclusions follow in Section V.

II. EMPIRICAL FRAMEWORK

In the standard economic literature, the demand function for goods is derived from the utility-maximizing model. Under this framework, consumers' demand for goods depends on their income as well as the price of the good. As mentioned, cigarette smoking is a major health hazard. Since the early 1960s, governments and non-profit agencies in developed countries have mounted extensive media campaigns to educate the public about the effects of smoking.[3] Thus, a distinctive feature of cigarette demand studies has been to incorporate the influence of health information into the demand model. In the U.S., Hamilton (1972) found that the dummy variables representing information on health risks had a significant effect on cigarette consumption over the period 1952 through 1970. Additionally, Schneider et al. (1981) found that anti-smoking campaigns from 1964 through 1978 led to a 37 percent decline in per capita consumption. In recent studies, Hu and colleagues found that anti-smoking media campaigns had a significantly negative impact on per-capita cigarette consumption in California (Hu et al., 1995a, 1995b). Similar empirical evidence about the effects of anti-smoking publicity on the demand for cigarettes can be found for European countries (Atkinson and Skegg, 1973; Leu, 1984).

Based on the framework of these models, we constructed an empirical model for cigarette demand as follows:

$$(1)\ C_t = a_0 + a_1 P_t + a_2 Y_t + a_3 H_t + a_4 X_t + \varepsilon_t$$

where C_t is the quantity of cigarettes demanded at period t, P_t is the price of cigarettes, Y_t is the income variable, H_t is a measure of smoking-related health information, X_t is the vector for other determinants, and ε_t is a random error term. Equation (1) is a standard model of cigarette demand, which states that cigarette consumption depends on the price of cigarettes, income, and anti-smoking campaigns. Based on economic

theory, plus evidence from previous studies, we predict that the parameters a_1 and a_3 are negative, and a_2 is positive, if cigarettes are normal goods.

Most empirical literature treats price as exogenous in estimating equation (1). However, because the price of cigarettes is jointly determined by supply and demand, this approach may be subject to problems of simultaneous-equations estimation bias. Thus, following Keeler et al. (1993), we will use instrumental variables to take into account the endogenous problem of the price variable.

Cigarettes are addictive, due to their nicotine content (U.S. Department of Health and Human Services, 1989). Therefore, another distinctive feature of cigarette demand studies is the incorporation of the addictive nature of the good into the model. Traditionally, the myopic addictions model has been used to estimate demand for such goods. This model incorporates past quantity demanded at time t-1 (C_{t-1}) into equation (1) (Fuji, 1980; Baltagi and Levin, 1986). More recently, Becker and Murphy (1988) developed a rational addiction model in which consumers are held to anticipate the expected consequences of their current actions. Under this framework, current cigarette consumption is modeled as a function of both past and future consumption. Thus, the rational addiction model incorporates both the past quantity demanded at time t-1 and future quantity demanded at time t+1(C_{t+1}) into the right-hand side of equation (1) (Becker et al., 1994).

One advantage of these addiction models is that we can separate short- and long-run responsiveness of cigarette consumption to price changes. The other advantage is that whether consumers are addicted, and whether they are rationally or myopically addicted, can be empirically tested by estimating coefficients for C_{t-1} and C_{t+1} (Sung et al., 1994). A study by Becker et al. (1994) supports the rational addiction model and finds that the short-run price elasticity is -0.4 while the long-run elasticity

is -0.7. Other literature provides similar results (Keeler et al., 1993; Sung, et al., 1994). The primary purpose of incorporating addictive framework into our analysis is not to test the rational addiction hypothesis, but rather to determine whether our demand elasticities are sensitive to the addictive model specification.

Models discussed so far assume that cigarettes manufactured in Taiwan and in developed countries are homogeneous. Given that the cigarette market in Taiwan was closed before 1987, consumers may believe cigarettes manufactured abroad differ in taste and quality. It also is important to determine whether imported cigarettes serve as substitutes or complements. In a study of cigarette consumption in Japan, Haden (1990) disaggregated cigarettes into three types: Japanese cigarettes, U.S. cigarettes, and other cigarettes. He found that Japanese and other cigarettes were substitutes, but Japanese and U.S. cigarettes were complements. These empirical results provide important clues for evaluating the impact of cigarette imports. Therefore, we further modify our empirical framework by disaggregating cigarettes into the following two types: cigarettes manufactured in Taiwan (domestic cigarettes) and cigarettes manufactured in developed countries (imported cigarettes). We specify the disaggregated model as follows:

(2) $C_{dt} = b_0 + b_1 P_{dt} + b_2 P_{it} + b_3 Y_t + b_4 H_t + b_5 X_t + \varepsilon_{1t}$

(3) $C_{it} = c_0 + c_1 P_{dt} + c_2 P_{it} + c_3 Y_t + c_4 H_t + c_5 X_t + \varepsilon_{2t}$

where C_{dt} and C_{it} are the quantities demanded of domestic and imported cigarettes, respectively, at period t. P_{dt} and P_{it} are the prices of domestic and imported cigarettes, respectively, ε_{1t} and ε_{2t} are random error terms. The parameters b_2 and c_1 measure the cross price effect of domestic and imported cigarettes. The domestic and imported cigarettes are substitutes if b_2 and c_1 are positive.

To proceed, we adopt a popular methodology: "from general to simple," proposed by London School of Economics and Hendry (Hendry and Richard 1982, and Gilbert 1986) to include all the potential explanatory variables. This will strengthen our fitting ability and not to suffer any loss of an important variable. We also consider the transfer function by including an AR(1) in the residual to correct possible serial correlation. We first estimate equation (1) using ordinary least squares(OLS). Following Keeler et al. (1993) and Becker et al. (1994), we then use two-stage least squares(2SLS) to take into account the endogenous problem of the price variable and past cigarette consumption, respectively. Finally, we use seemingly unrelated regression (SUR) to estimate equations (2) and (3).

III. DATA AND THE VARIABLES

The analysis is based on annual time-series data from Taiwan from 1966 to 1995. The data set contains thirty observations for each variables. Table 1 contains definitions, means, standard deviations and unit root tests for the dependent and explanatory variables. We obtained the cigarette sales data from the Taiwan Tobacco and Wine Statistical Yearbook, published by Taiwan Tobacco and Wine Monopoly Bureau (TTWMB, 1996). We expressed cigarette consumption as the number of packs sold per individual over 15 years of age.[4] We based annual population data on mid-year estimates obtained from the Ministry of the Interior (1995). Figure 1a shows the total quantity consumed per adult in Taiwan from 1966 through 1995. Figure 1b further decomposes the variation of per capita consumption by brands of cigarettes.

Figure 1 reveals two significant patterns of per capita cigarette consumption in Taiwan during the period studied. First, in contrast to other developed countries, cigarette consumption in Taiwan has not fallen steadily since 1966. Although some short-run fluctuations can be observed, annual cigarette consumption per adult grew from 95 packs in 1966 to a peak of 124 packs in 1987, and then declined to 116 packs in 1995. Second, the market share of imported cigarettes rapidly increased, from less than 2 percent to about 18 percent, in the first year the cigarette market was opened. By 1995, the market share of imports had grown to about 27 percent (see Table A1 in the appendix). Meanwhile, cigarette consumption per adult for domestic brands has fallen steadily since 1987.

The retail cigarette price was the average price per pack, weighted by the market share for each brand of cigarettes sold in Taiwan.[5] We obtained these data from TTWMB (1996) and the Tobacco Institute of the Republic of China. We further deflated the nominal price to 1991 New Taiwan dollars using the consumer price index for all goods. As Figure 2a indicates, the nominal price of cigarettes increased steadily, from 6 NT dollars in 1966 to 29 NT dollars in 1995. However, the real price remained almost stable during the earlier period and decreased gradually in more recent years. We further decomposed the variation of real price over time by type of cigarette in Figure 2b. As is evident from Figure 2b, the price of imported cigarettes declined significantly after the cigarette market was opened. Additionally, the price decline for imported cigarettes was more substantial than that for domestic cigarettes. Consequently, the price gap between domestic and imported cigarettes gradually decreased.

We based per capita income on the annual estimates of disposable income reported by the Directorate-General of Budget, Accounting and Statistics (DGBAS,

1996a), and divided by the total population. We also deflated the income measure to 1991 New Taiwan dollars using the consumer price index for all goods. We obtained the consumer price index from DGBAS (1996b).

As mentioned, in addition to price and income, anti-smoking informational campaigns have been identified as a third influence on cigarette smoking. The literature mentions three approaches to measuring this effect: (1) health scare variable; (2) a market share measure; and (3) a direct measure by expenditure. The first approach models the informational effect on cigarette consumption using zero-one dummy variables for the periods in which the hazardous effects of smoking were publicized. For example, Leu (1984) used three dummy variables to measure extended publicity in 1964, 1966 and 1978/79 in Switzerland. Other studies, such as those by Hamilton (1972) and Fuji (1980), used a similar approach to measure three major episodes of anti-smoking publicity in the U.S.

Schneider et al. (1981) pointed out that the zero-one specification is inappropriate because anti-smoking information has been disseminated as a sequence of findings, and because changes in knowledge and attitudes also occur over time. They noted that dissemination of information in 1953 about the health hazards of smoking led to the rapid introduction and acceptance of filter-tip brands in the U.S. Thus, they used market share of filter cigarettes as an indication of the magnitude of the 1953 health information shock. Similarly, they used the market share of low-tar brands over time as an indication of the impact of the U.S. Surgeon General's 1964 report on smoking.

A third approach uses expenditures for anti-smoking media campaigns to measure the informational impact. Hu et al. (1995b), for instance, constructed a media campaign variable based on the dollar amount spent for anti-smoking campaigns

since the passage of Proposition 99 in California.[6] Their results suggest that the media campaign variable had a significant effect on reducing cigarette sales.

We use two of these three measures of health information in this study. First, following Schneider et al. (1981), we use the market share of low-tar brands for domestic cigarettes to measure the spread of anti-smoking information in Taiwan. In response to the marketing campaigns of foreign tobacco manufacturers, TTWMB first introduced low-tar cigarettes in 1988.[7] The low-tar cigarettes grew rapidly from a market share of 8.76 percent in 1988 to 43.53 percent eight years later (Table A1). Because the Taiwanese government and many interest groups adopted a series of anti-smoking campaigns during this period,[8] the expansion of market share for low-tar cigarettes reflects the consumer's response over time to new information. Second, we use a dummy variable to measure the impact of more strongly worded warning labels adopted in 1992.[9] The value for the variable representing warning label is 0 before 1991 and one thereafter.

Other explanatory variables we use in the analysis include the market share of imported cigarettes and the female labor force participation rate. Using the actual data for market share of imported cigarettes over time allows us to investigate the impact of cigarette imports on overall cigarette consumption and on the consumption of domestic cigarettes.[10] The annual data on female labor force participation rate came from DGBAS (1996c). This variable captures other socioeconomic determinants of cigarette smoking as well.

For time series analysis, the stationarity is an important issue. From Table 1, the result of unit root test[11] shows that most of the variables are I(1) (with unit root in level and without unit root after the first difference). The Z test by Phillips and Perron shows a consistent result but the ADF test does not show a clear cut for us to make a

decision. For example, the domestic cigarette consumption and income, the ADF test shows unit root might still exist after the first difference. Since the ADF statistics here are close to the margin of 10% and it was argued by Phillips and Perron that ADF test does not have good power, we will continue as all the variables considered are I(1) and proceed under the cointegration analysis. Note that the variable of warning level is a dummy variable and low tar variable is zero before 1985 and linear increases thereafter. The unit root test on those two variables is not adequate.

IV. EMPIRICAL ANALYSIS

Since all the variables we interested are either with unit root or dummy, trend type variables, we will carefully proceed under the cointegration analysis. Because what we interested are the relationships between level of the variables in the single equation or simultaneous equations. It is important to verify variables are cointegrated to avoid the problem of spurious regression. Usually, the simple OLS model can provide a basic understanding of all the important coefficients and elasticities. However, the simultaneous bias reveals the estimated coefficients are not consistent. Following Hsiao (1997), the traditional estimation method and testing procedures can still be applied among the unit root processes in the structural system equations if the processes are cointegrated. This means that the use of the traditional instrumental variables method or two (three) stages estimation procedure in the cointegrated system is still valid. We can get the consistent estimators, and the Wald type tests are still reliable.

Moreover, after the model is estimated, the residuals can provide information about whether our model is adequate. We will consider several residual diagnostic tests: the Jarque-Bera statistic test for normality, the Ljung-Box Q statistic test for serial correlation, the Lagrange Multiplier statistic test for ARCH, the White test for

heteroskedasticity (with cross terms). However, we only have thirty observations. All the estimating and testing results must be interpreted with caution.

Table 2 presents several specifications for equation (1). We report whether the variables in the model is cointegrated, the rank that likelihood ratio test suggested, the estimated results and residual tests. The coinegration test we employed is the maximum likelihood ratio test developed by Johansen.[12] In the testing result, it can also suggest how many cointegrating vectors should be included if proceed to the error correction model. However, Wickens (1996) argued that it is hard to give a satisfactory economic interpretation to estimated cointegrating vectors without any prior information and transformation. Fortunately, we do not have this problem. We only care about a direct relationship from estimation of single or simultaneous equation to get the coefficients and calculate the elasticities.

Model 1 is the most general model with an AR(1) residual correction. Because the AR(1) correction is not significant, we drop it in Model 2. In Model 3, we omit other insignificant parameters and reduce to a parsimonious one. Models 4 and 5 consider the simultaneous bias and uses two stage least square method to estimate. Model 5 includes lag one of past consumption to represent the myopic addition consideration. We can see all the model we considered are cointegrated. The diagnostic tests on residual shows no systematic information is left on the fitted model.

The estimated results indicate a substantial and significantly negative effect of prices on cigarette consumption. This result is quite robust because the price coefficients change only slightly and remain strongly significant in all specifications. The results also show that the price elasticities derived from these estimates (measured at sample means) range from -0.6 to -0.7. We also compare the estimated results for different functional forms. The unreported results indicate our price elasticities of cigarette demand are not sensitive to the functional form chosen. These estimates imply that a 10 percent increase in cigarette prices causes a decrease in cigarette consumption of 6 percent to 7 percent.

Compared to other recent studies of cigarette demand based on U.S. aggregate data, our findings for price elasticities suggest that the price responsiveness of cigarette consumers in Taiwan is a little greater than that of their counterparts in the United States.[13] Warner (1990) suggests two plausible explanations for this result. First, the effect of price increases on the consumer's ability to purchase other goods and services is greater in Taiwan because per capita income is lower. Second, Taiwanese consumers on average consume fewer cigarettes than do their counterparts in the U.S.[14] Therefore, they may be less addicted, hence better able to reduce consumption in response to price increases.

Table 2 also shows a significantly positive effect of income on cigarette consumption. This results shows that income elasticity, calculated at the means of the variables, was about 0.2 during the study period. This is quite close to elasticities obtained from other recent cigarette demand studies (Viscusi, 1992). Our estimates of the income effect are quite robust to variations in specification and functional form. The elasticity estimates imply that cigarettes are normal goods.

Results of the effects of anti-smoking information are consistent with prior expectations. The estimated coefficient of the "low tar" variable is negative and statistically significant at the 1 percent level. This indicates that an increase in the market share of low-tar cigarettes will lead to a reduction in total cigarette consumption. As suggested by Schneider et al. (1981), the growth of low-tar cigarettes is a market response to the spread of anti-smoking information. Thus, the estimate provides indirect evidence that anti-smoking campaigns have a significant and negative effect on total per capita cigarette consumption. Based on Model 1 of Table 2, the calculated elasticity of cigarette demand with respect to the market share of low-tar cigarettes is -0.05. That is, a 10 percent increase in market share of low-tar cigarettes would lead to a 0.5 percent reduction in total cigarette consumption. The

elasticity estimate is robust across specifications.[15] The negative effect of anti-smoking publicity on consumption is further supported by the estimated result of the warning-label dummy, although the coefficient is not statistically significant.

The parameter estimates on the import share variable are positive, but only Model 3 is statistically significant at the 10 percent level. Hence these results offer support, albeit mild, for the positive effect of cigarette imports on total cigarette consumption. Based on Model 3 of Table 2, the calculated elasticity of cigarette demand with respect to the market share of imported cigarettes is 0.025. As shown in the appendix table, the market share of imported cigarettes increased from 1.94 percent to 17.68 percent during the first year of opening cigarette market. This change implies an 811 percent growth in the market share of imported cigarettes in 1987. Based on this figure and the elasticity estimate, we infer that opening the market to cigarette imports led to a 20 percent increase in per-capita cigarette consumption in 1987. This estimated effect is larger than the average effect for the four Asian countries found by Chaloupka and Laixuthai (1996).

When the price variable is treated as endogenous (in Model 4), the estimated results in Table 2 are similar to those reported above. An exception to this is that the estimated value of price elasticity changes slightly (from -0.6 to -0.7). This indicates that the simultaneous-equations estimation bias, if any, is extremely small.

The coefficients for lagged consumption are positive, but statistically insignificant in both the ordinary least-squares (not shown in the table)[16] and two-stage least-squares estimates (in Model 5 of Table 2). This result suggests that no significant addictive effect of cigarette consumption exists, and that consumers in Taiwan adjust their cigarette consumption completely in one time period to changes in prices and income. The estimated results from the myopic addiction model are

similar to those reported above, also indicating that our basic results are not sensitive to the presence of addictive behavior.

Table 3 reports the coefficient estimates for the disaggregated models.[17] The cointegration test reveals that the individual equations in Model 6 and 7 are also cointegrated. The disturbances of the equations are expected to be correlated, then SUR estimator is more efficient because it takes account of the entire matrix of correlations of all of the equations. The estimators in the SUR model minimize the determinant of the covariance matrix of the disturbances (Zellner 1962). For domestic cigarettes, the own-price effect is negative and statistically significant at the 5 percent level. For imported cigarettes, the own-price effect is also negative, but statistically insignificant. The cross-price effects are positive in both equations, indicating that domestic and imported cigarettes are substitutes. Based on the model 6 of Table 3, the own-price elasticities for domestic and imported cigarettes, calculated at sample means, are -0.6 and -1.1, respectively. The cross-price elasticities are 0.08 and 2.78 for domestic and imported cigarettes, respectively. These results suggest that the consumption of imported cigarettes is more sensitive to price changes than is that of domestic cigarettes.

Regarding income effects, we find that the consumption of both imported and domestic cigarettes is positively related to income, but the elasticity values are quite different for the different types of cigarettes. Imported cigarettes have a greater elasticity with respect to income than do domestic cigarettes. This is consistent with the finding obtained in Haden (1990). A plausible explanation for this result is that imported cigarettes are considered to be of higher quality than domestic cigarettes.[18]

The coefficient for the "low-tar" variable is significantly negative in the equation for domestic cigarettes, but is significantly positive in the equation for imported

cigarettes. This result indicates that the spread of anti-smoking information, as measured by the market share of low-tar cigarettes, decreases per-capita consumption of domestic cigarettes while it increases consumption of imported cigarettes. A plausible explanation for this result is that imported cigarettes may contain less tar and nicotine than domestic cigarettes. Therefore, in response to anti-smoking informational campaigns, consumers substitute imported for domestic cigarettes. Although the estimated coefficients of the warning-label dummy are negative in both equations, they are statistically insignificant.

Finally, the market share of imported cigarettes has a significantly negative impact on per-capita consumption of domestic cigarettes. This estimated result shows that the elasticity of domestic cigarette consumption with respect to the market share of imported cigarettes is -0.08. That is, a 10 percent increase in the market share of imported cigarettes would lead to a 0.8 percent reduction in per-capita consumption of domestic cigarettes. This result, in combination with the estimates in Table 2, suggests that cigarette imports have led to two significant outcomes in Taiwan: (1) they have induced smokers to switch to imported cigarettes; and (2) they have increased overall cigarette consumption. We call the former influence a switching effect and the latter a market expansion effect. The switching effect is a natural consequence of market competition and new entry. The market expansion effect, however, is of concern because of the serious consequences of cigarette smoking.

V. CONCLUSION

In this study, we use aggregate time-series data to estimate the price elasticities of cigarette demand in Taiwan. We also examine the impact on cigarette consumption of

opening cigarette market, and of anti-smoking campaigns. Our results indicate that cigarette-smoking is responsive to price, with a price elasticity of -0.6 to -0.7. We also find that domestic cigarettes and imported cigarettes are substitutes. And we discover that demand for imported cigarettes is more price-responsive than is demand for domestic cigarettes. Further, our analysis underscores the negative effect anti-smoking campaigns can have on consumption. In addition to evidence on price and informational effects, our analysis offers mild support to the argument that opening the market to cigarette imports has resulted in significant increases in overall cigarette consumption.

Developed countries have long sought to reduce cigarette consumption. Their approaches often center on taxation and the dissemination of information on smoking's health hazards. Our analysis sheds light on the potential effectiveness of such policies in Taiwan. First, our results indicate that a tax increase could have a strong effect on cigarette consumption in Taiwan. According to our estimates, a 10 percent increase in the price of cigarettes, (for instance, from a 3 NT dollars increase in excise tax), would lead to a 6 percent to 7 percent reduction in cigarette consumption. Currently, the TTWMB regulates the price of domestic cigarettes, and the Ministry of Treasure receives the monopoly profits as revenue. For imported cigarettes, the excise tax is NT$ 16.6 per pack, equivalent to 45 percent of the average retail price in 1990 (Hsieh et al., 1996, pp. 88-90). This tax rate remains significantly lower than those imposed by developed countries, except the U.S. (Hu, 1995). Therefore, tax increases remain a potential policy tool.

Secondly, our findings generally confirm the effectiveness of anti-smoking publicity in reducing cigarette consumption. During the period 1987 through 1995, the Taiwanese government spent NT$ 71.3 million on anti-smoking campaigns. A

study based on individual survey data (Hsieh et al., 1996) has confirmed the positive effects of this campaign. However, Hsieh also found that public awareness of smoking's health hazards are far from universal. Further, Taiwan spends proportionately less on anti-smoking publicity than does the United States (Hu et al., 1995b). As mentioned, California imposed a 25-cent cigarette tax increase in 1988, of which 20 percent funds anti-smoking educational campaigns. Our results indicate that duplicating California's approach could significantly reduce cigarette consumption in Taiwan.

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NOTES

* The authors are associate research fellow, the Institute of Economics, Academia Sinica, Taipei, Taiwan, and Professor of Health Economics, University of California, Berkeley, CA, and Associate Professor of Economics, National Taiwan University, Taipei, Taiwan, respectively. This is a revised version of a paper presented at the 72nd Annual Conference of Western Economic Association International, Seattle, July 9-13, 1997, in a session organized by Yea-Mow Chen, San Francisco State

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1. For example, U.S. annual per capita cigarette consumption was 2,534 in 1970. This figure declined to 2,156 in 1989 (Viscusi, 1992, pp. 53-55). A similar trend also has been observed in other European countries, such as United Kingdom and Switzerland (Leu, 1984; Townsend, 1987).

2. In Taiwan, cigarettes have been produced by a state-run monopoly firm(Taiwan Tobacco & Wine Monopoly Bureau, TTWMB) since 1905. Before 1987, the TTWMB also had a monopoly power to import cigarettes. In 1987, as a result of trade negotiation, the cigarette market in Taiwan was opened to cigarettes produced by foreign countries, first to the United States, and then to other developed countries. For a detailed discussion of the cigarette market in Taiwan, see Hsieh et al. (1996, pp. 88-90) and Chaloupka and Laxiuthai (1996, pp. 6-8).

3. For example, a series of U.S. Surgeon General's reports indicate that higher morbidity and mortality rates are observed in smokers for many diseases, such as lung cancer, chronic bronchitis and emphysema, and ischemic heart disease (U.S. Department of Health and Human Services, 1989).

4. Since actual aggregate consumption data often is not available, most literature make use of cigarette sales data to measure the demand for cigarettes. As suggested by Baltagi and Levin (1986), this approach may lead to a biased estimate for price elasticity due to cigarette smuggling. In the United States, cigarette smuggling arises because of the variation in tax rates across states. Consumers in states with higher taxes may purchase cigarettes from states with lower taxes. Therefore, researchers can explicitly control for the smuggling effect by using neighboring prices, or an incentive variable reflected disparities among state excise taxes(Baltagi and Levin, 1986; Becker et al., 1994; Sung et al., 1994). Taiwanese consumers, in contrast, do not engage in cigarette smuggling. Instead, organized criminals may smuggle cigarette into the country to increase the profits through avoiding taxation. Because a monopoly firm (TTWMB) produced and sold cigarettes in Taiwan before 1986, we compared the TTWMB cigarette sales revenue to family expenditure on tobacco for 1966 through 1986 (TTWMB, 1996; DGBAS, 1996a). The

comparison reveals less than a 5 percent difference between these two sets of data.

5. After the market was opened to imports, the weight for imported cigarettes only included nine leading brands, which accounted for about 94 percent of imported cigarettes sold in Taiwan.

6. The state of California passed Proposition 99, the California Tobacco Tax and Health Promotion Act, in 1988. This act increased the tax on each package of cigarettes from 10 cents to 35 cents beginning January 1989. It earmarked 20 percent of the revenue raised by this new tax for educational programs to reduce cigarette consumption. For detailed discussion of Proposition 99, see Hu et al. (1995a, 1995b).

7. Low tar cigarettes have a tar content of 12 to 16 mg per stick(personal communication from an officer of TTWMB).

8. For example, government expenditures allocated to anti-smoking campaigns increased from NT$ 1 million in 1987 to about 16 million in 1995(Table A1). For detailed discussion about anti-smoking campaigns in Taiwan, see Hsieh et al.(1996, p.90).

9. Taiwan began requiring warning labels in all cigarette advertising and on every package of cigarettes in 1987, the first year it opened its doors to imports. The government strengthened the contents of the warning labels in 1992. For a more detailed discussion, see Hsieh et al. (1996, p. 90).

10. An alternative approach to measuring the impact of cigarette imports is to define a dummy variable which equals one for the years after cigarette markets were opened to foreign competition. However, as mentioned, the government in Taiwan also adopted several anti-smoking policies after the liberalization of cigarette trade. Thus, the dummy variable may be confounded with other policy effects. For this reason, we exclude this zero-one specification in the analysis.

11. Using the Z test, we have to apply a method proposed by Newey and West (1987) to determine the truncation parameter to calculate the long run variance and then use in the non-parametric test. To apply the ADF test, we use Perron and Vogelsang (1992) to determine the optimum lags to prewhite the errors.

12. The cointegration test we applied here is Johansen test. Johansen's framework considers five combinations of these ingredients: 1.Series have means but the cointegrating equations do not have intercepts, 2. Series have means and the cointegrating equations have intercepts, 3. Series

have means and linear trends but the cointegrating equations have only intercepts, 4. Series have means and linear trends and the cointegrating equations have intercepts and linear trends, or 5. Series have means, linear, and quadratic trends but the cointegrating equations have only intercepts and linear trends. These five cases are nested from the most restrictive to the least restrictive, given any particular cointegrating rank. We only report the testing result and suggestion from the third model since most of the economic variables are suitable for this case.

13. Using pooled data from 46 states in the U.S. over the period 1963 to 1980, Baltagi and Levin (1986) obtained a price elasticity of -0.2. Based on monthly time-series data from California for 1980 through 1990, Keeler et al. (1993) obtained a short-run price elasticity of -0.3 to -0.5 and a long-run price elasticity of -0.5 to -0.6. Becker et al. (1994) obtained a short-run price elasticity of -0.4 and a long-run price elasticity of -0.75 using time-series data for 50 states and Washington, D.C. for the years 1955 through 1985. Sung et al. (1994) found that the price elasticity of cigarette demand was -0.40 in the short run and -0.48 in the long run. For a more complete survey on the estimates of price elasticity for cigarette demand, see Viscusi (1992, pp. 102-105).

14. In the U.S., per-capita cigarette consumption and the percentage of cigarette smoker were 125 packs and 29.8%, respectively, in 1985 (Viscusi, 1992, p. 53). In Taiwan, these figures were 81 packs and 28.2% in 1986 (TTWMB, 1987). Based on this data, we can infer that U.S. cigarette smokers, on average, consume 35 packs per month, while Taiwanese smokers consume 24 packs.

15. In addition to the spread of anti-smoking information, the supply-side factors, such as the price of tobacco and the degree of market competition, may also affect the market share of low-tar cigarettes. Thus, the “low-tar” variable could be endogenous. Using the real price of tobacco and the dummy variable representing the opening of the cigarette markets as instrument variables, we reestimate the first equation of Table 2 by 2SLS. The estimated results (not shown in the table) are similar to those reported in Table 2, indicating that our basic results are not sensitive to the endogenous specification of the “low-tar” variable.

16. If the past consumption is added in Model 1, the coefficient of past consumption is 0.3, the t-value is 1.6, and the significant level is 12%. The coefficients of other variables are almost identical to the result of Model 1.

17. The estimator of the seemingly unrelated regressions also allows for first order autocorrelation. In

our estimation, we assume that autocorrelation follows the form of $\varepsilon_{it} = \rho_i \varepsilon_{it-1} + u_{it} (i = 1,2)$.

18. If price is a signal of quality, we can easily find evidence to support this argument. As shown in Figure 2 and Table 1, imported cigarettes have a significantly higher price than domestic cigarettes. With respect to nominal price, the average prices of domestic and imported cigarettes were NT$ 23.3 and NT$ 43.5 per pack, respectively, in 1995.

ABBREVIATIONS

OLS: ordinary least squares

2SLS: two-stage least squares

TTWMB: Taiwan Tobacco and Wine Monopoly Bureau

DGBAS: Directorate-General of Budget, Accounting and Statistics

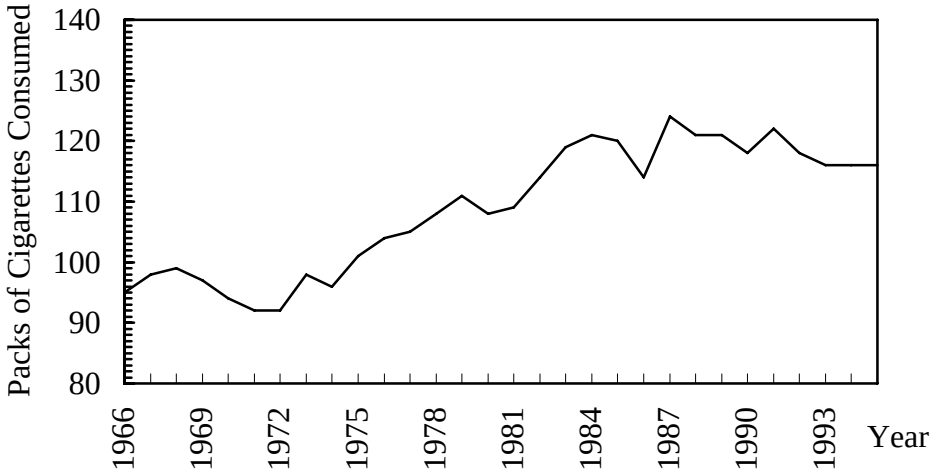

Figure1 (a). The annual per capita cigarette consumption of adults over 15 years of age in Taiwan, ALL Brands

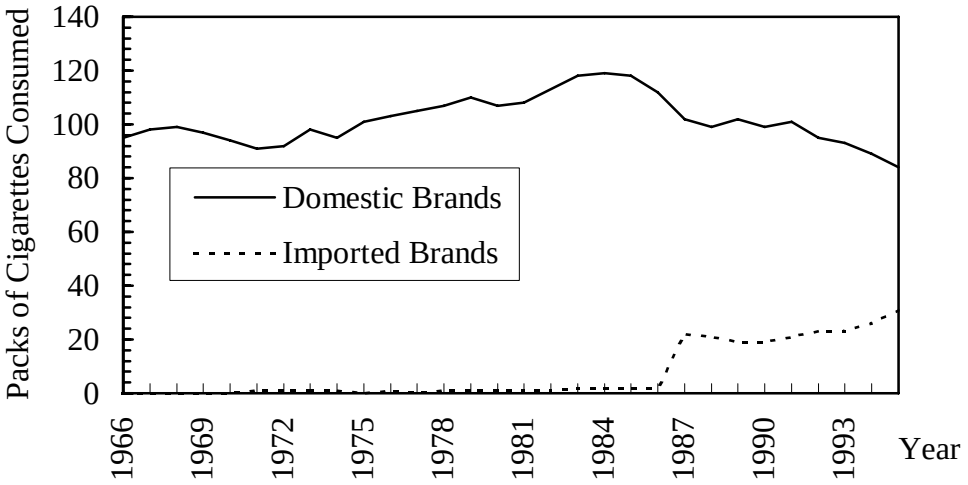

Figure 1(b). The annual per capita cigarette consumption of adults over 15 years of age in Taiwan, by Brands

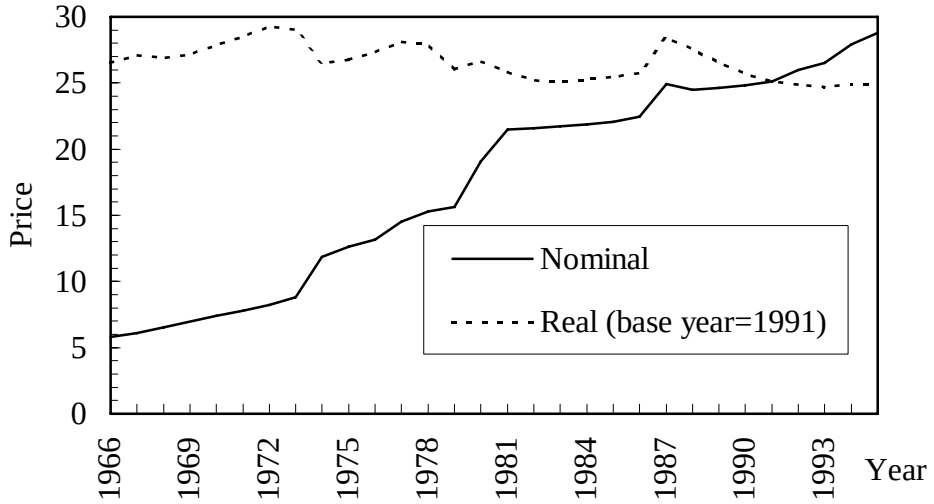

Figure 2(a). Cigarette prices in Taiwan, All Brands

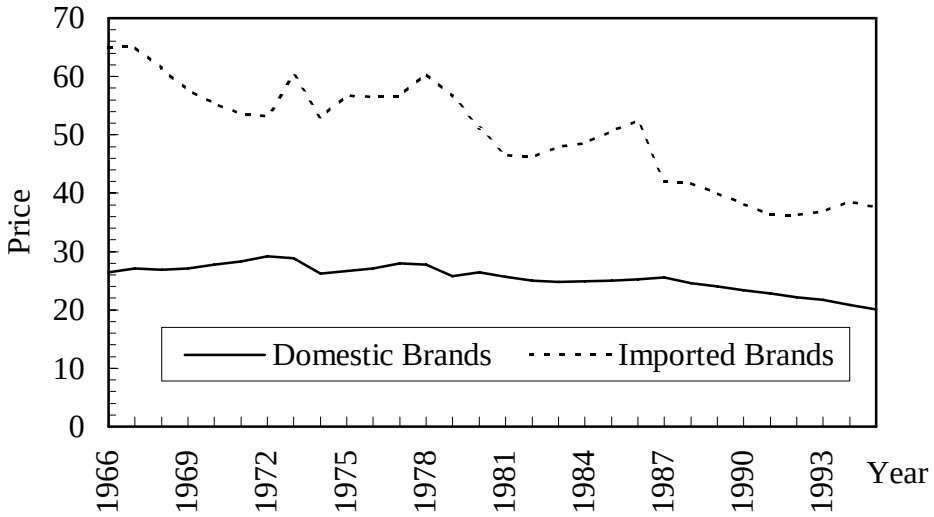

Figure 2(b). Real cigarette prices in Taiwan, by Brands

Table 1. Variable Definitions and Descriptive Characteristics

Variable	Definition	Mean (Std.)	L D	ADF test	Z test
Cigarette consumption	Annual per-capita cigarette consumption of adults over 15 years of age, in packs.	108.85	L	-1.25*	-1.59*
		(10.39)	D	-3.77	-6.66
Domestic cigarette consumption	Annual per-capita adult consumption for domestic cigarettes, in packs.	101.42	L	-0.55*	-0.34*
		(8.75)	D	2.93*	-3.88
Imported cigarette consumption	Annual per-capita adult consumption for imported cigarettes, in packs.	7.43	L	-1.42*	-1.48*
		(10.47)	D	-4.54	-5.48
Price	Average retail cigarette price per pack, in 1991 New Taiwan dollars.	26.56	L	-3.15*	-2.56*
		(1.35)	D	-3.97	-5.64
Domestic Price	Average retail price for domestic cigarettes per pack, in 1991 New Taiwan dollars.	25.50	L	-0.21*	-1.53*
		(2.31)	D	-4.37	-4.99
Imported Price	Average retail price for imported cigarettes per pack, in 1991 New Taiwan dollars.	50.08	L	-2.72*	-2.85*
		(8.99)	D	-3.73	-6.01
Income	Per-capita disposal income, in 1991 New Taiwan dollars.	126313.3	L	-1.45*	-1.22*
		(67863.00)	D	-3.49*	-3.84
Low tar	The share of low tar brands in the market of domestic cigarettes (%).	7.18	L	NA	NA
		(13.43)	D	NA	NA
Warning label	A dummy variable re-presenting the strengthened contents of warning labels adopted in 1992, zero before 1991 and one thereafter.	0.13	L	NA	NA
		(0.35)	D	NA	NA
Import	The market share of imported cigarettes (%).	6.30	L	-1.26*	-0.78*
		(8.83)	D	-4.51	-7.05
FLFP	Participation rate of female labor force (%).	40.59	L	-2.87*	-2.02*
		(4.18)	D	-4.65	-6.25

Notes:1.The exchange rate (NT$/US$) was 25.75 in December 1991. 2. L stands for the level and D stands for the differenced of the series. 3. The unit root test, we considered are test with constant term and time trend. 4. * means significant under 5% critical value.

Table 2. Estimated Coefficients of the Cigarette Demand Equation

Independent Variable	Model 1. (OLS)	Model 2. (OLS)	Model3. (OLS)	Model 4. (2SLS)	Model 5 (2SLS)
Cointegrated	Yes	Yes	Yes	Yes	Yes
LR test suggested	Rank= 3	Rank= 3	Rank= 3	Rank= 3	Rank= 3
Estimation result:					
Past consumption	-	-	-	-	0.009 (0.017)
Price	2.294**	-2.542***	-2.626***	-2.999**	-2.609*
	(-2.716)	(-3.625)	(-4.005)	(-3.250)	(-1.740)
	[-0.56]	[-0.62]	[-0.64]	[-0.73]	[-0.64]
Income	0.00019**	0.00021***	0.00019***	0.00019***	0.00019
	(2.691)	(3.574)	(7.023)	(2.914)	(1.600)
	[0.22]	[0.24]	[0.22]	[0.22]	[0.22]
Low tar	-0.806***	-0.819***	-0.873***	-0.832***	-0.871*
	(-3.740)	(-4.396)	(-7.904)	(-4.407)	(-2.251)
Warning label	-2.996	-3.093	-	-3.193	-
	(-0.767)	(-0.874)		(-0.894)	
Import	0.497	0.383	0.434*	0.484	0.428
	(1.593)	(1.506)	(1.789)	(1.679)	(1.533)
FLFP	-0.115	-0.219	-	-0.118	-
	(-0.186)	(-0.430)		(-0.225)	
Intercept	150.58***	162.53***	158.15***	172.67***	156.68*
	(5.341)	(7.528)	(8.305)	(6.785)	(1.835)
AR(1)	0.271		-	-	-
	(1.021)				
Summary Satatistics:					
R^2	0.93	0.93	0.93	0.93	0.92
Adj R^2	0.91	0.91	0.92	0.91	0.91
D.W.	1.85	1.71	1.63	1.77	1.63
SE of regression	3.13	3.07	3.01	3.10	3.14
J-B	0.74	0.31	0.13	0.22	0.13
L-B Q(2)	0.397	0.52	0.41	0.51	0.45
B-G(2)	0.121	0.49	0.36	0.47	0.49
ARCH(2)	0.70	0.81	0.59	0.71	0.57
White	0.27	0.22	0.21	0.22	0.15

Notes: 1. Asymptotic *t*-statistics are in parentheses. 2. Price and income elasticities calculated at their means are reported in square brackets. 3. The instruments in Model 4 consist of real cost of tobacco, average salary of tobacco manufacture, and a dummy variable for opening market for foreign cigarettes plus the other explanatory variables in the model. The instruments in Model 5 consist of one-period lag of price, income, and cigarette tax, and two-period lag of the price and tax variables, plus the other explanatory variable in the model. 4. The cointegration test we applied here is Johansen test, assuming that series have means and linear trends but the cointegrating equations have only intercepts. Model 5, past consumption is not included in the cointegration test. 5. J-B denotes Jarque-Bera statistic test for normality, L-B Q(2) denotes 2 lags included in the Ljung-Box Q statistic test for serial correlation, ARCH(2) denotes 2 lags included in the Lagrange Multiplier statistic test for ARCH. 6. ***, **, and * denote coefficients that are statistically significant at the 1% level, 5% level, and 10% level, respectively (two-tail test).

Table 3. Estimated Coefficients of the Cigarette Demand Equations, by Brands

Independent variable	Model 6 (SUR)		Model 7 (SUR)	
	Domestic Brands	Import Brands	Domestic Brands	Import Brands
Cointegrated	Yes	Yes	Yes	Yes
LR test suggested	Rank=2	Rank=1	Rank= 1	Rank= 1
Estimation result:				
Domestic price	-2.63***	0.81	-3.45***	0.89
	(-4.62)	(1.13)	(-3.81)	(1.24)
	[-0.66]	[2.78]	[-0.87]	[3.05]
Imported price	0.16	-0.16	0.31	-0.19
	(1.13)	(-0.87)	(1.38)	(-1.05)
	[0.08]	[-1.08]	[0.15]	[-1.28]
Income	0.00021***	0.000084***	0.00012***	0.000085**
	(7.46)	(2.58)	(3.00)	(2.61)
	[0.26]	[1.42]	[0.15]	[1.44]
Low tar	-0.72***	0.45**	-1.23***	0.36**
	(-5.51)	(3.17)	(-9.47)	(3.47)
Warning label	-3.99	-3.58	-	-
	(-1.31)	(-0.93)		
Import	-1.26***	-	-	-
	(-7.15)			
Intercept	147.89***	-18.72	167.09***	-19.23
	(8.24)	(0.82)	(5.77)	(-0.83)
Summary Satatistics:				
R^2	0.91	0.89	0.75	0.89
Adjusted R^2	0.88	0.87	0.71	0.87
S.E. of regression	2.98	3.75	4.67	3.73
L-B Q(2)	0.543	0.064	0.006	0.026
B-G (2)	0.535	0.0439	0.026	0.021
ARCH(2)	0.819	0.923	0.177	0.036
Determinant residual covariance	88.474		76.733	

Notes: 1. Asymptotic *t*-statistics are in parentheses. 2. Price and income elasticities calculated at their means are reported in square brackets.3. ***, **, and * denote coefficients that are statistically significant at the 1% level, 5% level, and 10% level, respectively (two-tail test).

Appendix

Table A1. The Features of Cigarette Market in Taiwan,1986-1995.

Year	Market share of imported cigarettes (%)	Government expenditure of media campaigns (in million NT dollars)	Market share of low-tar brands for domestic cigarettes (%)
1986	1.94	0.00	0.00
1987	17.68	1.00	0.00
1988	17.68	1.00	8.76
1989	15.75	0.95	15.01
1990	15.97	2.50	20.75
1991	16.92	10.83	24.84
1992	19.20	11.83	30.03
1993	19.58	10.90	33.73
1994	22.50	16.45	38.67
1995	26.89	15.81	43.53

Source: TTWMB (1996) and unpublished data of the R.O.C. Department of Health.